Chapter 7
WATER SOURCE OPTIONS

Water source options are options that make additional water available from existing or new sources, such as reclaimed water or the Floridan aquifer, or options that reduce water use, such as conservation. This section discusses options that increase water availability.

WATER CONSERVATION

In the late 1980's, the District experienced severe drought conditions. As a result of the drought, the District examined its rules concerning drought management and made changes to the Basis of Review (BOR) for Water Use Applications. These changes included water conservation requirements for all classes of water use. Examples of requirements such as adoption of ordinances that affect irrigation hours, landscaping and plumbing fixture ordinances, leak detection, rate structures, and public education are discussed in detail in this chapter. These changes have, over the years since adoption, largely been incorporated into existing water use permits. Consequently, every day water use has become more "efficient."

Water conservation refers to any beneficial reduction in water use losses. Practices and technologies that provide the services desired by the users, while using less water, help achieve long-term permanent reductions in water use. This separates them from the short-term water conservation measures and cutbacks that are required of users during water shortage situations or when short-term problems with the capacity of supply systems occur. Because of their short-term emergency nature, water shortage reductions rely almost exclusively on behavioral changes by the users (e.g., skipping or rescheduling lawn watering and taking shorter showers). Water conservation, generally requires changes in water use systems and technology, and little behavioral change. The water use reductions resulting from conservation will provide a basis for adjusting historic rates and patterns of water use in the modeling of the LWC Water Supply Plan.

Mandatory Water Conservation Measures

In District water use permitting rule amendments adopted in October 1992, specific water conservation requirements were imposed on public water supply utilities (and associated local governments), on commercial/industrial users, on landscape and golf course users, and on agricultural users. All of these requirements apply to users required to obtain individual water use permits. Water use (consumptive use) permitting is further discussed in Chapter 5.

Public Water Supply Utilities

All individual permit applicants for a potable public water supply permit must submit a water conservation plan at the time of permit application. Utilities operated by private entities and those public utilities providing service to an area beyond their political boundary are required to document the fact that they requested local governments within their service area to adopt conservation ordinances.

The conservation plan must address the following elements:

- Adoption of an irrigation hours ordinance
- Adoption of a Xeriscape™ landscape ordinance
- Adoption of an ultra-low volume fixtures ordinance
- Adoption of a rain sensor device ordinance
- Adoption of a water conservation based rate structure
- Implementation of a leak detection and repair program
- Implementation of a water conservation public education program
- An analysis of reclaimed water feasibility

The mandatory water conservation program requires that each utility evaluate and take applicable action on all elements. The elements consist of a combination of water conservation ordinances and water conservation activities. Utilities must rely on local governments to codify the water conservation ordinances. Depending on the demographics and location of the service area, utilities can choose to demonstrate which water conservation activities are more cost effective for the situation and emphasize implementation of those activites in their conservation plan.

The implementation status of the water conservation measures within regional public water supply utility service areas in the LWC Planning Area are indicated in **Table 19**. Analysis for reclaimed water feasibility is omitted from this table. All utilities that have an associated wastewater treatment facility have conducted a study. Generally, because of the autonomy of local governments in the LWC Planning Area, each ordinance has to be adopted by each unit of local government for the measure to be fully implemented. Positive responses in **Table 19** reflect the adoption of the appropriate ordinance by the applicable local government, within the majority of the utility's service area.

Adoption of an Irrigation Hours Ordinance

The ordinance limits all lawn and ordinance irrigation to the hours, of 4:00 P.M. to 10:00 A.M. at a minimum. Irrigation during daytime hours is generally less efficient. The sunlight and increased winds during the daytime hours cause some of the water to evaporate before hitting the ground or to blow onto impervious surfaces such as

Table 19. Implementation Status of Mandatory Water Conservation Measures.

Utility Service Area	Ordinance Required				Ordinance Not Required			
	Irrigation Hours	Xeriscape / Landscape	Ultra Low Vol. Plumbing Fixture	Rain Sensor Device	Conservation Rate Structure	Utility Leak Detection /Repair	Water Conservation Public Education	Reclaimed Water Feasibility
Lee County								
Lee County Utilities	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Bonita Springs	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Island Water Assoc.	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Fort Myers	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Greater Pine Island	Yes	No	Yes	No	Yes	No	Yes	No
Cape Coral	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Gulf Corkscrew/San Carlos	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Lehigh	Yes	No	Yes	No	Yes	No	Yes	Yes
Collier County								
Immokalee	No	Yes	Yes	Yes	Yes	No	Yes	Yes
Naples	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Marco Island Utilities	No	Yes	No	Yes	No	Yes	Yes	Yes
Golden Gate	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Everglades City	Yes	No	No	Yes	Yes	No	No	Yes
Collier County Utilities	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Port of the Islands	No	Yes	Yes	Yes	No	No	Yes	No
Hendry County								
Clewiston	No	No	No	No	No	Yes	No	Yes
LaBelle	No	No	Yes	No	No	Yes	No	Yes
Port LaBelle	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Glades County								
Moore Haven	No	Yes	Yes	No	No	Yes	No	No
Charlotte County								
No Public Water Supply Systems in Planning Area								

Yes: Water Conservation Measure Used; No: Measure Not used.

sidewalks, roads and driveways. The wind also causes the water that reaches the plants to be more unevenly applied. In addition to changing the time of irrigation, users should to reduce the length and frequency of irrigation. Public education programs can contribute to the irrigation hours ordinance by informing irrigators how they can reduce applications while still meeting the water requirements of their plants.

The permit applicant or enacting local government may adopt an ordinance that includes exemptions from the irrigation hour restrictions for the following circumstances, irrigation systems and/or users:

- Irrigation using a micro irrigation system
- Reclaimed water end users
- Preparation for or irrigation of new landscape
- Watering in of chemicals, including insecticides, pesticides, fertilizers, fungicides, and herbicides when required by law, recommended by the manufacturer, or constituting best management practices
- Maintenance and repair of irrigation systems
- Irrigation using low volume hand watering, including watering by one hose attended by one person, fitted with a self-canceling or automatic shut off nozzle or both
- Users irrigating with 75% or more water recovered or derived from an aquifer storage and recovery system

Adoption of a Xeriscape™ Landscape Ordinance

Xeriscape™ is defined by the Florida Legislature to mean “a landscaping method that maximizes the conservation of water by the use of site appropriate plants and an efficient watering system” (Section 373.185, F.S.). The principles of Xeriscape™ include planning and design, soil analysis, efficient irrigation, practical turf areas, appropriate plant selection, and mulching.

The legislation requires that the water management districts establish incentive programs and provide minimum criteria for qualifying Xeriscape™ codes. These codes prohibit the use of invasive exotic plant species, set maximum percentages of turf and impervious surfaces, include standards for the preservation of existing nature vegetation, and require a rain sensor for automatic sprinkler systems. District rules, as mandated by the legislature, require that all local governments consider a Xeriscape™ ordinance and that the ordinance be adopted if the local government finds that Xeriscape™ would be of significant benefit as a water conservation measure relative to the cost of implementation. The Xeriscape™ landscape ordinance will affect new construction and landscapes undergoing renovation which require a building permit.

The District finds that the implementation and use of Xeriscape™ landscaping, as defined in Section 373.185, F.S., contributes to the conservation of water. The District further supports adoption of local government ordinances as a significant means of achieving water conservation through Xeriscape™ landscaping.

Adoption of an Ultra Low Volume Fixture Ordinance

This measure requires adoption of an ordinance that requires the installation of ultra-low volume (ULV) plumbing fixtures in all new construction. The District's water use permit regulations specify that the fixtures have a maximum flow volume when the water pressure is 80 pounds per square inch (psi) as follows: toilets, 1.6 gal/flush; showerheads, 2.5 gal/min.; and faucets, 2.0 gal/min. The previous standard for plumbing devices (before September 1983) included: toilets, 3.5 gal/flush; showerheads, 3.0 gal/min.; and faucets, 2.5 gal/min. These District regulations are consistent with the maximum water use allowed for showerheads and faucets manufactured after January 1, 1994 (US Code: title 42, Section 6295 of the Energy Policy Act) and conform to current Building Construction Standards (Chapter 553.14, F.S.).

ULV fixtures save water by using less water to provide the services desired. Available data indicate that the performance of the systems result in savings per unit (per flush or per minute); the savings will not be offset by having the users increase the number of units (number of double flushes or length of shower). Consequently, permanent ongoing water savings can be achieved, without the users making any behavioral changes.

Adoption of a Rain Sensor Device Ordinance

This measure requires adoption of an ordinance that requires any person purchasing or installing an automatic sprinkler system to install, operate, and maintain a rain sensor device or an automatic switch. This equipment will override the irrigation cycle of the sprinkler system when adequate rainfall has occurred.

Adoption of a Conservation Rate Structure

A conservation rate structure is a rate structure used by utilities that provides a financial incentive for users to reduce demands. Water conservation rates generally involve the following:

- Increasing the block rate, where the marginal cost of water to the user increases in two or more steps as water use increases
- Seasonal pricing, where water consumed in the season of peak demand, such as from October through May, is charged a higher rate than water consumed in the off peak season
- Quantity based surcharges
- Time of day pricing

Maddaus (1987) also lists uniform commodity rates as a conservation rate structure.

Users faced with higher rates will often achieve water conservation by implementing a number of the conservation measures discussed in this chapter. The most frequently used conservation rate structure used by utilities is increasing block rates. This rate structure generally is expected to have the largest impact on heavy irrigation users. The responsiveness of the customers to the conservation rate structure depends on the existing price structure, the water conservation incentives of the new price structure, and the customer base and their water uses.

Adoption of a Utility Leak Detection and Repair Program

The District encourages public water supply systems to have no more than 10 percent unaccounted for water losses. The implementation of leak detection programs by utilities with unaccounted for water losses greater than 10 percent is required. The leak detection program must include water auditing procedures, and infield leak detection and repair efforts. The program description should include the number of man hours devoted to leak detection, the type of leak detection equipment being used and an accounting of the water saved through leak detection and repair.

Implementation of a Water Conservation Public Education Program

Public information, as a water conservation measure, involves a series of reinforcing activities to inform citizens of opportunities to reduce water use, give reasons why they should choose to practice water conservation, and publicize the conservation options being promoted by the District, local governments and utilities. Virtually all users can be affected by public information efforts, although they are typically targeted at the uses with the broadest participation, including domestic indoor and outdoor uses.

Analysis of Reclaimed Water Feasibility

For potable public water supply utilities that control a wastewater treatment plant, an analysis of the economic, environmental, and technical feasibility of making reclaimed water available is required.

Commercial/Industrial Users

District regulations require that all individual commercial / industrial permit applicants submit a conservation plan.

Conservation plans must include the following:

- An audit of water use
- Implementation of cost effective conservation measures
- An employee water conservation awareness program
- Procedures and time frames for implementation
- The feasibility of using reclaimed water

Landscape and Golf Course Users

Landscape and golf course permittees are required to use Xeriscape™ landscaping principles for new projects and modifications when they find this to be of significant benefit as a conservation measure relative to its cost. They are also required to install rain sensor devices or switches, irrigate between the hours of 4:00 P.M. and 10:00 A.M., and analyze the feasibility of using reclaimed water. There are, however, six specific exceptions to the irrigation hour's limitations in the rule which provide for protection of the landscape during stress periods and help assure the proper maintenance of irrigation systems.

Agricultural Users

Citrus and container nursery permittees are required to use micro irrigation or other systems of equivalent efficiency. This applies to new installations or upon modifications to existing irrigation systems. The permittees are also required to analyze the feasibility of using reclaimed water.

Supplementary Water Conservation Measures

Urban Users

Indoor Audit and Retrofit. Indoor audits provide information and services directly to households and other urban water users to achieve greater efficiency in the use of indoor water using appliances. This option generally includes inspections to locate leaks and determine if plumbing devices are operating properly, repair of minor problems, and providing information on conservation measures and devices. In some cases, a retrofit program will include installation of water conserving showerheads and toilet dams.

Residential retrofit measures encourage the installation of ULV plumbing fixtures or modifications, which improve the performance of existing fixtures. One possible incentive is a partial financial subsidy to increase the installation of ULV water fixtures. Another incentive, recently undertaken in Tampa, is the delivery of retrofit kits to homes. The targeting and participation in efforts such as this will generally affect only a portion of the population. Utilities and local governments can devise programs, that carefully target the most cost effective applications of these measures. In retrofit programs, one option is to target residences with only high water consuming fixtures (generally those built pre-1980). Another option is to include residences with low water use fixtures (post-1980) for retrofit with ULV water use fixtures.

Another characteristic, which will increase the savings and the cost effectiveness of retrofit of the earlier dwelling units (homes), is that many of these units have fewer bathrooms and fixtures per unit and per person. The larger the number of people using a retrofit device, the more cost effective and water saving the retrofit. An appropriate strategy would be to target homes with large numbers of persons per fixture for complete retrofit, and other homes for retrofit of only the most heavily used fixtures. This suggests that a particularly suitable target for retrofit programs are public rest rooms and other facilities that have high use rates.

Landscape Audit and Retrofit. Landscape audits are measures that improve the efficiency of irrigation systems, and include services to determine if the irrigation system is operating properly. This may include adjustments to irrigation timers (to assure that a water conserving schedule is being followed), head replacement (to assure that the system is providing adequate coverage and not wasting water by irrigating impervious surfaces), recalibration of the irrigation system, and installation of rainfall sensing/irrigation control devices.

Utilities and other water management agencies generally implement audits. Because of the large outdoor component of water use in South Florida, irrigation audits can be effective. This is particularly important due to the peaking of outdoor demand during periods of low rainfall and maximum stress on water resources.

Landscape retrofit measures provide information and incentives for users to implement physical changes to their landscapes and irrigation systems. Devices suitable for landscape retrofit include those that prevent unnecessary irrigation by detecting recent rainfall or sensing soil moisture. Other retrofit options include replacing existing landscaping with site appropriate plants and practicing landscape management, which includes rezoning irrigation systems and mulching.

Cost and water savings for several indoor and outdoor urban retrofit water conservation measures are provided in **Tables 20** and **21**. In addition, the cost and water savings for irrigation system conversion for agricultural uses are discussed. The information in this section should not be interpreted as a cost-benefit analysis of these conservation measures, since no discounting is applied to the streams of costs and benefits.

Table 20. Representative Water Use and Cost Analysis for Retrofit Indoor Water Conservation Measures.

Representative Water Use	Toilet	Showerhead
Cost/unit ($)	$200.00	$20.00
Flushes/day/person	5	--
Gallons saved/flush	1.9	--
Minutes/day	--	10
Gallons saved/minute	--	2
Persons/unit	2.5	2.5
Life (years)	40	10
Savings/year/unit (gallons)	8,670	9,125
Savings/unit/over life (gallons)	346,800	91,250
Cost/1,000 gallons saved	$0.58	$0.22

For the urban water conservation methods, the analysis indicated the savings are greater than the costs. The savings per unit of cost associated with the outdoor conservation measures are generally greater than those for indoor conservation measures, primarily because of the larger volumes of water involved per unit affected by the outdoor conservation measures. Water savings associated with the implementation of retrofit programs can be significant. For example, if 10,000 showerheads were retrofitted in an

Table 21. Representative Water Use and Cost Analysis for Retrofit Outdoor Water Conservation Measures.

Representative Water Use	Rain Switch	Mobile Irrigation Lab
Cost/unit or visit ($)	$68.00	$50.00[a]
Acres/unit	0.11	0.11
Water savings (inches/year)	70	70
Water savings (gallons/year)	209,070	209,070
Life (years)	10 years	7 years
Water savings/life (gallons)	2,090,700	1,463,493
Cost/1,000 gallons saved ($)	$0.033	$0.034

a. Represents additional cost of site visit (currently compensated by NRCS and the District).

area, this could result in a water saving of 182 MGY (0.50) MGD). Likewise, if 10,000 irrigation systems were retrofitted with rain switches, this could result in a water savings of over 2 BGY (5.73 MGD).

Public Water Supply Utilities

Filter Backwash Recycling

This measure encourages water utilities using filter systems that are cleaned by backwashing (cleaning the filter by reversing the flow of water) to recycle the backwash water to the head of the treatment plant for retreatment. Otherwise, the backwash water is usually disposed of into a pit from which the water seeps back into the ground.

Distribution System Pressure Control

Potable water distribution system pressure control measures reduce water usage while providing acceptable water pressures to all customers. System pressure should keep water-using devices working properly while providing for public health and fire safety needs. Pressure reduction valves and interconnecting and looping utility mains, are methods used to equalize and, therefore, reduce overall operating pressure. Unlike the pressure reduction efforts during water shortages, which call for reductions in pressures to levels necessary to meet minimums for fire flow, these changes target reductions at locations where pressures are high within the system.

Control of pressures can save water in a number of ways. High pressures increase losses of water through leaks, and increase use when the amount of water used is based on time rather than the volume of water discharged. Irrigation systems on timers are the major uses wherein the use is for set periods of time. High pressures cause increases in water application and can cause atomization of the spray, which reduces irrigation efficiency. Low pressures, however, reduce the areas covered by poorly designed sprinkler systems, and this results in stress to the uncovered areas. This may encourage users to increase irrigation time in an attempt to improve the results of the irrigation efforts.

Wastewater Utility Infiltration Detection and Repair

Wastewater utility infiltration detection and repair includes estimation and detection efforts to quantify and locate the infiltration of ground water or surface water into wastewater collection systems, and repair efforts to reduce the infiltration. Reducing infiltration of ground water prevents waste by allowing the ground water to be used for other purposes. In coastal areas, infiltration of saline ground water minimizes the reuse potential by increasing the chloride level. Infiltration also uses available treatment and disposal capacity.

Agricultural Users

Irrigation Audit and Improved Scheduling

Growers are encouraged to adopt irrigation management practices that conserve water. To assist growers with agricultural irrigation, the federally funded Mobile Irrigation Laboratory that operates in the LWC Planning Area carries out audits. Agriculture is a major water user in the LWC Planning Area. Changing on farm irrigation scheduling and water management practices will play an increasingly important role in agricultural water conservation.

Irrigation management practices and technology interact, so that for example, a change in the type of irrigation system will generally require a change in irrigation scheduling to achieve the goal of water conservation while maintaining crop yield and economic return. An additional factor in agricultural water conservation is the energy savings possible through water conservation.

Micro Irrigation Systems

Micro irrigation systems achieve water savings by directly applying a high percentage of water to the root zone of the crop in controlled amounts, so losses through deep percolation, drainage, etc. are reduced. In addition, application of water to areas not underlain by the root zone is limited. Installation of micro irrigation systems, or systems of equivalent efficiency, are required for new citrus and projects container nursery projects. Additional water savings can be achieved by promoting the installation of water conserving irrigation systems on crops where it is not required (such as vegetables), and retrofitting irrigation systems for existing citrus and nursery crops. The percentages of crops irrigated by micro irrigation systems (drip and trickle) during 1995 are discussed in Appendix F.

Conversion of existing flood irrigated citrus to micro irrigation is another potential source of water savings **(Table 23)**. It is estimated by IFAS that the initial cost to install a micro irrigation system on citrus is $1,000 per acre and the system would have estimated annual maintenance costs of $25 per year (IFAS, 1993).

Table 22. Irrigation Costs and Water Use Savings Associated with Conversion from Seepage Irrigation to Low Volume Irrigation.

Initial cost ($/acre)	$1,000.00
Operating cost ($/acre	$25.00
Water savings (inches/yr)	8,519
Water savings (gallons per year)	230,805
Life (years)	20
Cost over life ($)	$1,500.00
Water savings over life (gallons)	4,616,100
Cost/1,000 gallons saved ($)	$0.33

The table summarizes the cost and potential water savings from one acre of conversion. The water savings from converting 25,000 acres of citrus from flood irrigation with 50 percent efficiency to micro irrigation with 85 percent efficiency could result in water saving of approximately 6 BGY or 15.8 MGD. The analysis illustrates that given the large volumes of water used for irrigation by agriculture, water conservation savings (which can be achieved at a reasonable cost) will often be extremely cost effective compared to the costs of developing additional water supplies.

WELLFIELD EXPANSION

Expansion of an existing public water supply wellfield is usually selected by a utility when additional raw water is required. The costs related to wellfield expansion for the major aquifer systems in the LWC Planning Area are currently being revised. Until this information becomes available, less recent cost information is provided in **Table 23**. The costs were based on a 16-inch diameter well and a maximum Surficial Aquifer well depth of 200 feet and maximum Floridan Aquifer well depth of 900 feet.

Ground water wells are limited in the amount of water they can yield by the rate of water movement in the aquifers, the rate of recharge, the storage capacity of the aquifer, environmental impacts, and proximity to sources of contamination and saltwater intrusion. These factors together determine the number, size, and distribution of wells that can be developed at a specific site. Long range planning by the water suppliers to identify future wellfield sites, and to protect those future sites from contamination by controlling land use activities within the influence of the wellfield, is important in ensuring satisfactory future water supply.

Table 23. Well Costs for Aquifer Systems.

Aquifer System	Drilling Cost (per well)	Equipment Cost (per well)	Engineering Cost (per well)	Operations and Maintenance Cost (per 1,000 gallons)	Energy Cost (per 1,000 gallons)
Surficial	$45,185	$61,501	$16,317	$.004	$.025
Intermediate[a]	$43,930	$61,501	$16,317	$.004	$.030
Intermediate[b]	$62,757	$61,501	$15,062	$.004	$.035
Floridan	115,472	$65,267	$17,572	$.004	$.040

a. In northern Lee and Hendry County, the average depth is 200'.
b. In Collier, southern Lee and Highlands County, the average depth is 300'.
Source: PBS&J, 1991, Water Supply Cost Estimates. Cost were converted to 1999 dollars.

UTILITY INTERCONNECTIONS

Interconnection of treated and/or raw water distribution systems between two or more utilities can provide a measure of backup water service in the event of disruption of a water source or treatment facility. When considering future potable water needs, bulk purchase of treated water from neighboring utilities should be evaluated in lieu of expanding an existing withdrawal and/or treatment plant. Additionally, large user agreements are taken into account in calculating water use allocations. A detailed study of distribution systems proposed for interconnection should address system pressures, physical layout of the supply mains, impacts on fire flows and compatibility of the waters.

RECLAIMED WATER

Encouragement and promotion of the use of reclaimed water and water conservation are formal state objectives. The Water Resource Implementation Rule (Chapter 62-40 F.A.C.) requires the FDEP and water management districts to advocate and direct the reuse of reclaimed water as an integral part of water management programs, rules, and plans. Several regulations also require an evaluation of reuse versus other disposal methods prior to issuance of Water Use permits. Statutory and rule provisions for reuse of reclaimed water are included in Appendix A.

Reuse is the deliberate application of reclaimed water for a beneficial purpose, in compliance with the FDEP and water management district rules. Reclaimed water is wastewater that has received at least secondary treatment and is reused after flowing out of a wastewater treatment plant (Chapter 62-610, F.A.C.). Potential uses of reclaimed water include landscape and agricultural irrigation, ground water recharge, industrial uses, environmental enhancement and fire protection. Additional discussion of reuse, including reclaimed water regulations and more detailed information on potential uses, is provided in Appendix H.

Reclaimed Water Costs

The costs associated with implementation of a reuse program vary depending on the size of the reclamation facility, the facility equipment needed, the extent of the reclaimed water transmission system, and the regulatory requirements. Some of the major costs to implement a public access reuse system include the following:

- Advanced secondary treatment
- Reclaimed water transmission system
- Storage facilities
- Alternate disposal
- Application area modifications

Cost savings include negating the need for or reducing the use of alternative disposal systems, negating the need for an alternate water supply by the end user, and reduction in fertilization costs for the end user. These costs and savings are further discussed in Chapter 5 of the LWC Planning Document.

Existing Treatment Facilities

There are 22 existing regional wastewater treatment facilities in the LWC Planning Area with a FDEP permitted capacity equal to or greater than 0.50 MGD. These facilities treated an average of 58 MGD in 1997. Nineteen of the facilities used reuse for all or a portion of their disposal needs in 1997 resulting in 37 MGD being reused. Reuse included irrigation of residential lots, medians, green space, golf courses, and ground water recharge via percolation ponds. In addition to reuse, 5 MGD was disposed of by deep well injection and 16 MGD was disposed of by surface water discharge. The volume of treated wastewater is projected in increase to 97 MGD by 2020. Summarized wastewater facility information is provided in Appendix D.

SURFACE WATER STORAGE

Surface water storage could be used by pumping surface water runoff and ground water seepage into regional storage systems during periods of excessive rainfall to provide additional water supply and flood protection. The capture of surface water runoff and ground water seepage in canals of the primary water management system, and storage of these waters in existing or new surface water reservoirs or impoundments, provides an opportunity to increase the supply of fresh water during subsequent dry periods. The primary problems associated with surface water storage are the expense of constructing and operating large capacity pumping facilities, the cost of land acquisition, appropriate treatment costs, the availability of suitable locations, and the high evaporation rates of surface water bodies (**Table 24**).

Table 24. Reservoir Costs.

Reservoir Type	Construction Cost $/Acre	Engineering Design Cost[a] $/Acre	Construction Administration $/Acre	Land $/Acre	Operations and Maintenance $/Acre
Minor Reservoir	3,567	505	399	5,648	148
Major Reservoir	10,016	1,135	566	5,648	132

a. Engineering costs include the permitting process, hydrogeologic investigation, monitoring during well construction, and design. Costs were converted to 1999 dollars.

AQUIFER STORAGE AND RECOVERY

Aquifer storage and recovery (ASR) is defined as the underground "storage" of injected water in an acceptable aquifer during times when water is available, and the subsequent "recovery" of this water when it is needed. Simply stated, the aquifer acts as an underground reservoir for the injected water, reducing the water loss to evaporation. Sources of injection water could include treated and untreated ground and surface water, and reclaimed water. **Table 25** presents the status of the ASR wells in the LWC Planning Area.

Aquifer Storage and Recovery Costs

Estimated project costs for ASR consisting of a 900-foot, 16-inch well, with two monitoring wells using treated water are shown in **Table 26**. One system uses pressurized water from a utility; whereas the second ASR system uses unpressurized treated water, thus requiring pumping equipment as part of the system cost. However, utilities implementing ASR systems may incur additional costs for surface facilities, such as piping, storage, and rechlorination. Other available data indicate that "typical unit costs for water utility ASR systems now in operation tend to range from $200,000 to $600,000 per MGD of recovery capacity" (CH2M Hill, 1993). At the same annual recovery rate used above (100 days at the daily recovery capacity), the costs per thousand gallons recovered would be $.30 to $.70 per thousand gallons. These systems have well capacities from 0.3 to 3 MGD and store treated water. Savings in treatment system costs are likely to be substantial when the ASR system offsets the need for additional treatment capacity to meet peaks in demands. Water for ASR should be reflected in the water use permit. The costs related to aquifer storage and recovery in the LWC Planning Area are currently being revised. Until this information becomes available, less recent cost information is provided in **Table 26**.

Table 25. Aquifer Storage and Recovery Facilities in Southwest Florida.

Facility Name	ASR Type	Pre-application	Construction Application Received	Construction Permit Received	Well Constructed	Operational Testing	Operation Permit
San Carlos Estates (Bonita Springs Utilities)	TDW		X				
Kehl Canal (Bonita Springs Utilities)	PTS		X				
Fort Myers	TDW		X				
Collier County	TDW						X
North Reservior (North Fort Myers)	TDW	X					
Olga	RSW	X					
Corkscrew (Lee County)	TDW						
Well 1					X		
Wells 2-6		X					
Marco Lakes	PTS						
Well 1						X	
Wells 2-9			X				

ASR types: TDW- potable through drinking water plant; RSW- raw surface water; PTS- partially treated surface water; RGW-raw ground water; RCW- reclaimed water. Source: 1999 personal communication with utility representatives.

Table 26. Aquifer Storage and Recovery System Costs.

System	Well Drilling Cost (per well)	Equipment Cost (per well)	Engineering Cost[a] (per well)	Operations and Maintenance Cost (per 1,000 gallons)	Energy Cost (per 1,000 gallons)
Treated Water at System Pressure	$251,026	$37,654	$451,847	$.005	$.08
Treated Water Requiring Pumping	$251,026	$125,513	$502,052	$.008	$.08

a. Engineering costs include the permitting process, hydrogeologic investigation, monitoring during well construction, and design.

Source: PBS&J, 1991, Water Supply Cost Estimates. Costs were converted to 1999 dollars.

Existing ASR Facilities

There are many ASR facilities in operation in the United States, including New Jersey, Nevada, California, and Florida. In Florida, there are numerous ASR projects in operation, under construction, or in permitting. Operational facilities include: Collier County, Manatee County, Peace River, Cocoa, Port Malabar, and Boynton Beach. All but the Marco Island facility use treated water. Marco Island uses raw surface water from a borrow pit. Collier County uses potable water. Lee County has completed their ASR well and is in the testing phase. Bonita Springs is in the permitting/design phase while several other entities are evaluating the feasibility of ASR. Additional information on ASR can be found at www.sfwmd.gov.

FLORIDAN AQUIFER SYSTEM (FAS)

In the LWC Planning Area, there has been increased use of the FAS for public water supply. The FAS yields nonpotable water throughout the LWC Planning Area. The quality of water in the FAS deteriorates, increasing in hardness and salinity from north to south. Salinity also increases with depth, making the deeper producing zones less suitable for development than those near the top of the system. The system is persistent and displays hydrogeologic characteristics favorable to ASR development.

Developments in desalination technology have made treatment of water from the upper portion of the FAS feasible in the LWC Planning Area where chloride concentrations are not prohibitively high. The cost of tapping the FAS in a given location would depend on a number of variables, including well construction, operation and maintenance, and water treatment. Cost estimates for drilling wells in the three major aquifer systems of the LWC Planning Area are discussed in the Wellfield Expansion section. Treatment costs of desalination technologies (e.g., reverse osmosis and electrodialysis reversal) are discussed in the Water Treatment Technologies section.

Water quality varies throughout the upper portion of the FAS. Generally speaking, the two parameters of greatest concern for use by reverse osmosis and other water treatment technologies are total dissolved solids (TDS) and chloride. For the period from 1985-1990, the common value for TDS in the upper portion of the FAS was 1,093 mg/L to 7,425 mg/L. For this same period, chloride ranged from 167 mg/L to 3,785 mg/L. These values vary with depth and production zone.

One of the major constraints on future development of the upper portion of the FAS is degradation of water quality rather than limited quantity. Upconing of saline water is an important consideration in planning additional development in the upper portion of the FAS.

SEAWATER

While seawater is plentiful and obtainable from the Gulf of Mexico, costs associated with the construction and operation of seawater reverse osmosis and distillation systems can be high. As with all surface waters, the Gulf of Mexico is also vulnerable to discharges or spills of pollutants which could impact a water treatment system. However, recent proposals to construct and operate a seawater desalination water supply for Tampa

Bay Water indicate these facilities can be constructed at a dramatically lower cost (as much as half) than previous experience. Four proposals to construct a 25 MGD seawater desalination water supply state water could be produced for less than $2.30 per thousand gallons, with one estimate as low $1.71 per thousand gallons for the first year (Tampa Bay Water Press Release, 1999).